NIAGARA MOHAWK

NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

April 15, 1980

Office of Inspection and Enforcement
Region I
Attention: Mr. R. T. Carlson, Chief
Reactor Construction and Engineering
Support Branch
U. S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

Dear Mr. Carlson:

Re: Nine Mile Point Unit #2
Docket No. 50-410

A potential reportable deficiency under 10 CFR 50.55(e) involving the Nine Mile Point Unit #2 biological shield wall was previously reported to Mr. L. Narrow of your staff on May 30, 1979. Attached is our interim report in accordance with Section 50.55(e) (3) of the Commission's Regulation.

A final report summarizing our tests and analyses and identifying any safety implications will be provided by August 1, 1980.

Very truly yours,

NIAGARA MOHAWK POWER CORPORATION

John H. Terry
Senior Vice President

cc: Director of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

8005210618

BIOLOGICAL SHIELD WALL

INTERIM REPORT

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I. Introduction

A. Statement of Problem

A number of biological shield wall shop weld joints have been nondestructively examined at the jobsite using both ultrasonic testing (UT) and magnetic particle testing (MT). The nondestructive examination has shown that defects which exceed American Welding Society (AWS) D1.1 maximum allowable defect sizes exist in the shop welds. A majority of the defects appear to be in the root area of single bevel backing bar welds. However, defects have also been discovered in double bevel welds and other areas of single bevel backing bar welds.

B. Overview of Report

The purpose of this report is to give a general description of the biological shield wall, including its functional requirements, load cases, and physical description; to present a history of the discovery of the weld defects and subsequent engineering and metallurgical investigations; and to present the plan for resolution of the biological shield wall problem.

C. Summary of Conclusions and Closure Plan

In order to demonstrate that the biological shield wall will provide radiation shielding and maintain structural integrity during an accident condition, all weld joints will be shown to be acceptable by either additional nondestructive examination and rework, as required, or technical justification based on stress analysis and metallurgical analysis.

The overall approach to biological shield wall completion involves three distinct groups of weld joints: inner wall to stiffener, (Figure 6 and 8); stiffener to stiffener, (Figure 7); and cover plate to stiffener (Figure 6 and 8). The inner wall to stiffener welds will be ultrasonically inspected from the inner wall. Defect sizes and locations will be mapped. Following an engineering evaluation to determine allowable defects for given locations, repairs will be performed on inner wall weld joint defects as required. The stiffener to stiffener welds will be evaluated based on an analysis using inner wall UT data and repaired as required. The cover plate to stiffener welds will be ultrasonically inspected. Defect sizes and locations will be mapped and based on engineering evaluation to determine allowable defects for given locations. Repairs will be performed as required.

II. Biological Shield Wall Description

A. Functional Requirements

Functional requirements of the biological shield wall include the following:

1. Providing shielding against radiation from the reactor vessel.

2. Providing anchorage support for pipe restraints, pipe supports, flooring beams, and insulation.

3. Providing support for the star truss/stabilizer system.

4. Protecting the reactor pressure vessel from pipe whip, jet impingement, and missile loads.

B. Load Cases

The biological shield wall was designed in accordance with the PSAR requirements of Section 12.5.2.8.3. The analysis and design of the biological shield wall was governed by the following loads:

1. Deadload and seismic loads

2. Accident temperature cases consisting of the maximum temperature differentials between the inner and outer walls occurring as the result of a loss-of-coolant accident

3. Accident pressure differential between the inner and outer walls occurring as the result of a loss-of-coolant accident

4. Pipe restraint loads occurring as the result of restraining pipes following a rupture

5. Jet impingement loads resulting when pressurized fluid from a ruptured pipe strikes the biological shield wall.

C. Physical Description

The biological shield wall will sit on the reactor pedestal (Figure 1) and will be attached to the pedestal by means of embedded anchor bolts (Figure 2). The biological shield wall consists of two concentric steel cylinders connected by horizontal and vertical stiffeners (Figures 3 and 4). The shield wall is 48 ft - 4 inches high and has an inner radius of 14 ft - 3/4 inch and an outer radius of 15 ft - 9 1/4 inches. The biological shield wall was fabricated in three rings, each approximately 16 feet high. Each ring was fabricated in three 120 degree sections. The inner and outer shells and the stiffeners are 1 1/2 inches thick, A537 Class 1 steel plates connected by full penetration welds. The space between the shells will be filled with nonstructural heavyweight concrete for neutron radiation shielding purposes. The shield wall is penetrated by air duct openings, inspection openings, instrumentation line pipe sleeve penetrations, and door openings for various piping systems. Attached to the wall are pipe restraints, a shield wall extension to support the star truss and stabilizer, clip angle supports for floor beams, and insulation support brackets.

REACTOR BUILDING CONFIGURATION

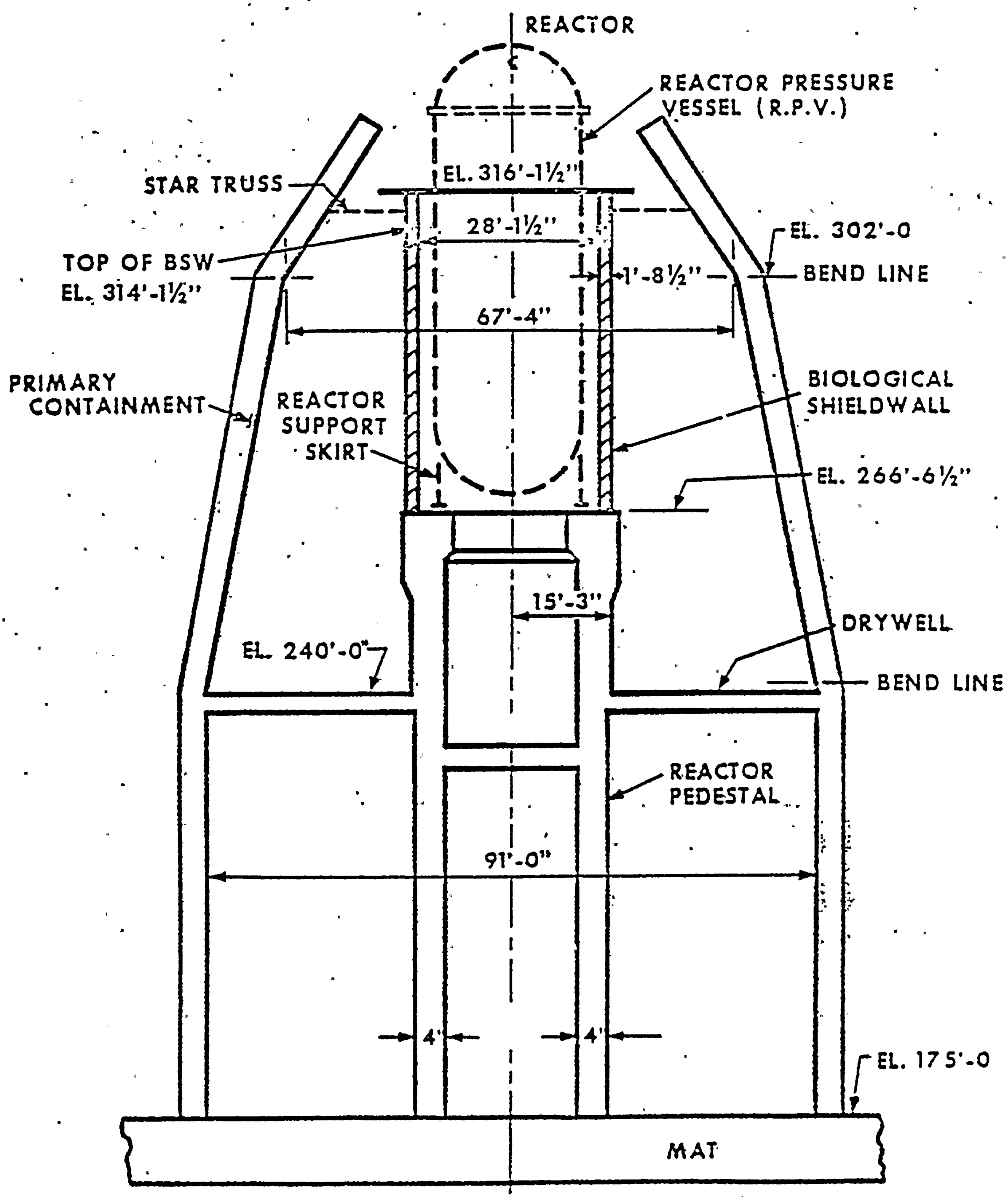

FIGURE 1

BASE DETAIL

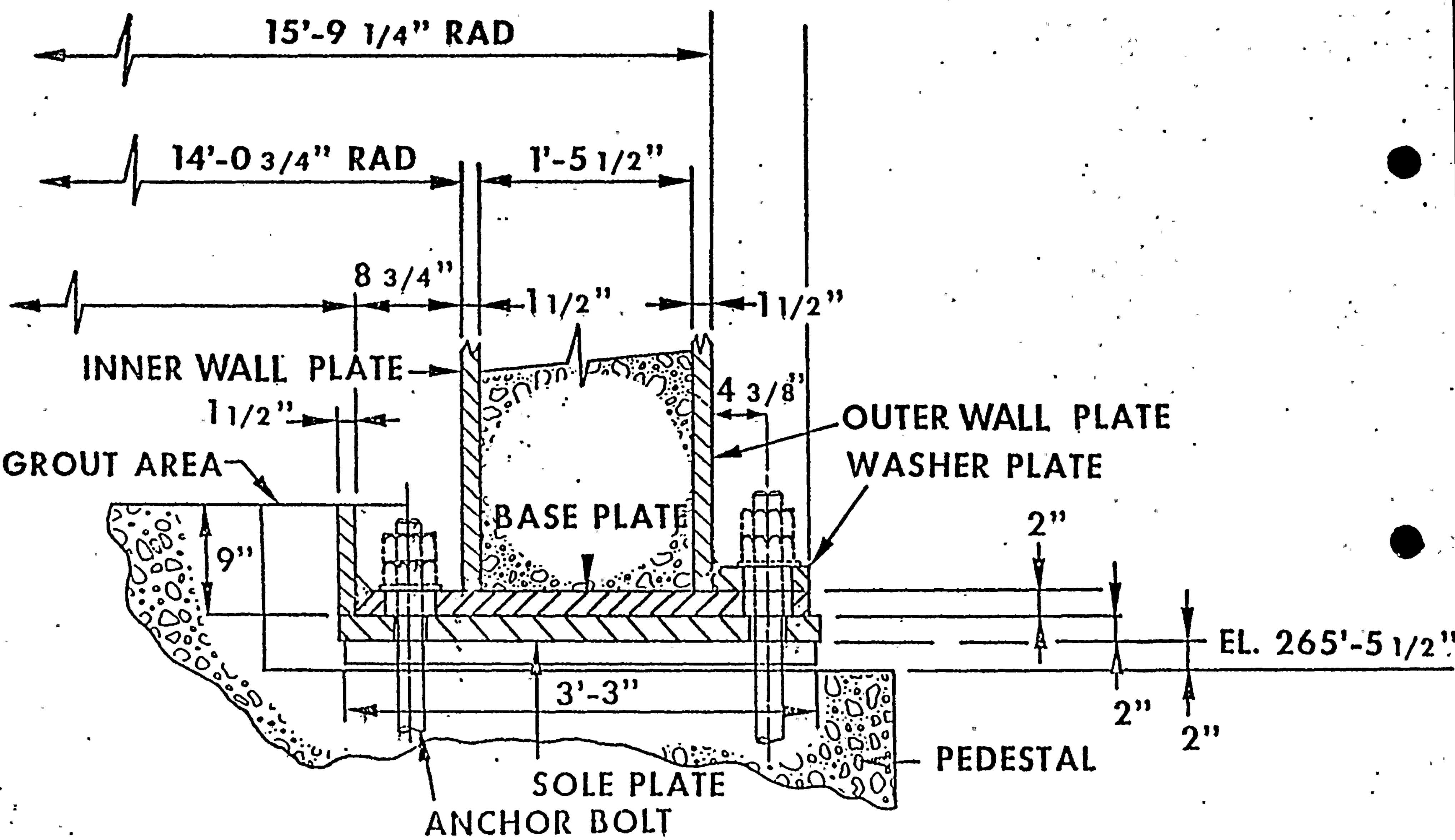

FIGURE 2

ELEVATION

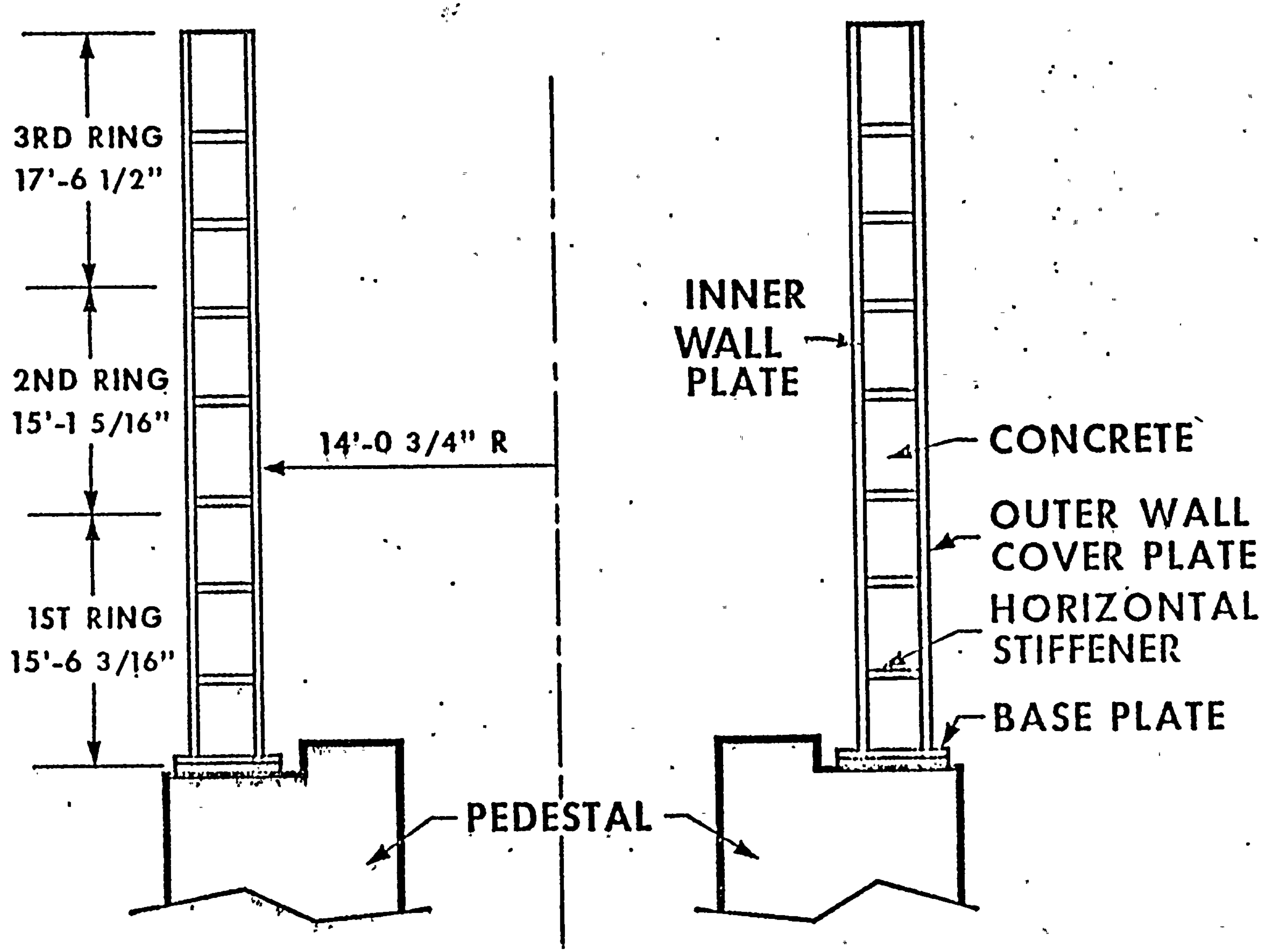

FIGURE 3

PLAN

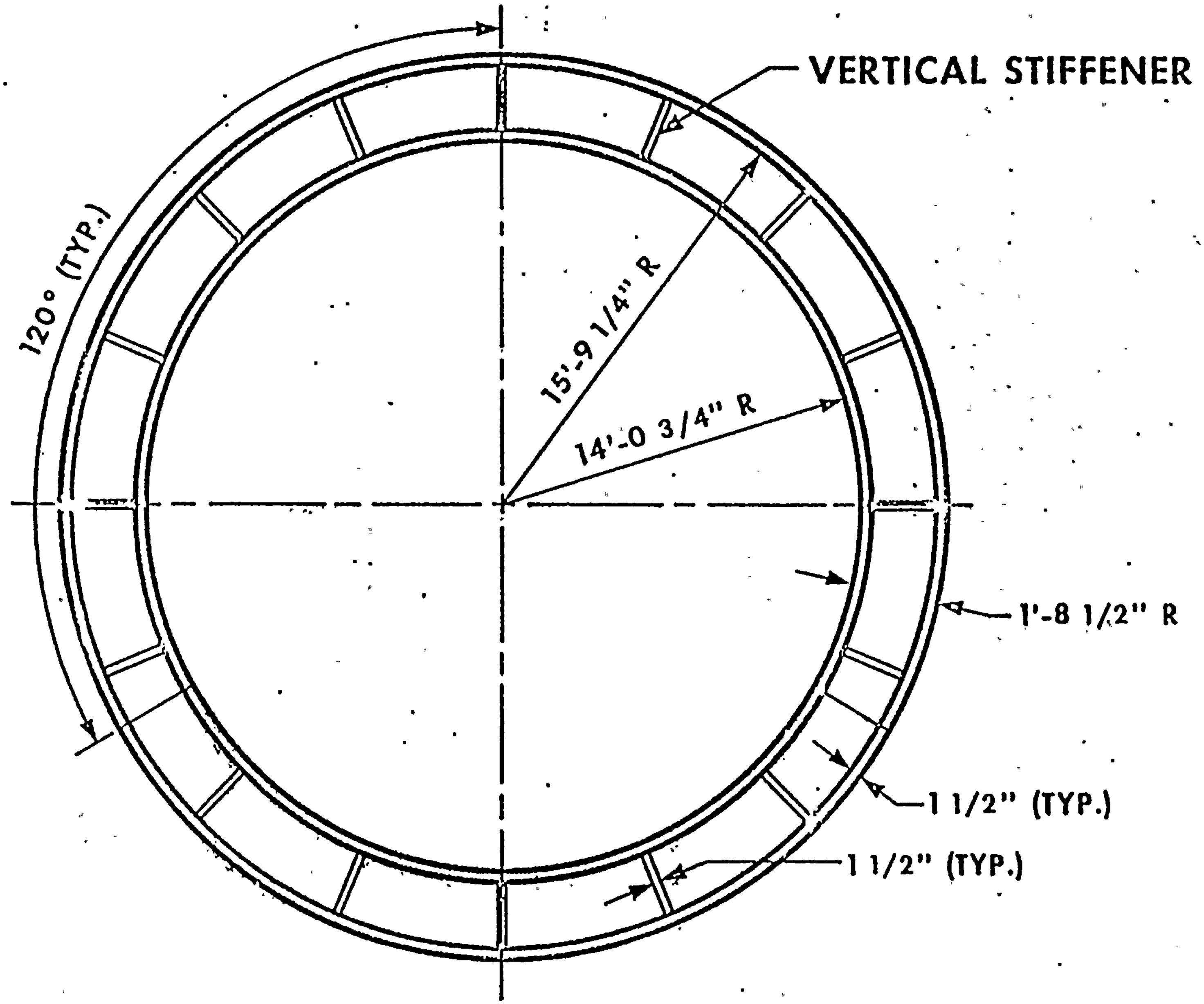

FIGURE 4

The full penetration welds used in the biological shield wall are both single bevel welds (with backing bars) and double bevel welds. The following table lists the various weld configurations, their abbreviations, and the figure in which they are shown.

Weld Joint	Abbreviation	Figure No.
Cover plate to base plate	CPBP	5
Vertical stiffener to inner wall	VSIW	6
Vertical stiffener to horizontal stiffener	VSHS	7a
Horizontal stiffener to inner wall	HSIW	8
Horizontal stiffener to vertical stiffener	HSVS	7b
Cover plate to horizontal stiffener	CPHS	8
Cover plate to vertical stiffener	CPVS	6

III. History of Events

The discovery of weld defects in the biological shield wall and subsequent action taken can be described in three separate phases: discovery of a potential problem, engineering investigation, and sample plan approach.

A. Phase I - Discovery of Potential Problem (May 1979)

Based on UT indications in the cover plate to base plate welds and visual indications discovered in the third ring horizontal stiffener to inner wall welds, the quality of backing bar welds for the entire biological shield wall was investigated.

B. Phase II - Engineering Investigation (June 1979 to August 1979)

The purpose of the investigation was to determine if a weld quality problem existed for the biological shield wall backing bar welds. The sequence of events for the second phase is as follows:

June	1.	A specimen was removed from the base plate to perform a metallurgical examination of cover plate to base plate indications (Figure 5).
June - July	2.	UT and MT inspections of the horizontal stiffener to inner wall (Figure 8)welds for all three rings were performed. The inspections were performed on random accessible welds. (MT results are shown in Appendix D.)
July		Based on unacceptable defects discovered by MT in the third ring horizontal stiffener to inner wall welds, additional MT inspection was performed on all accessible third ring horizontal stiffener to inner wall weld joints (approximately 2,000 inches out of a total of 6,000 inches).

COVER PLATE TO BASE PLATE WELD

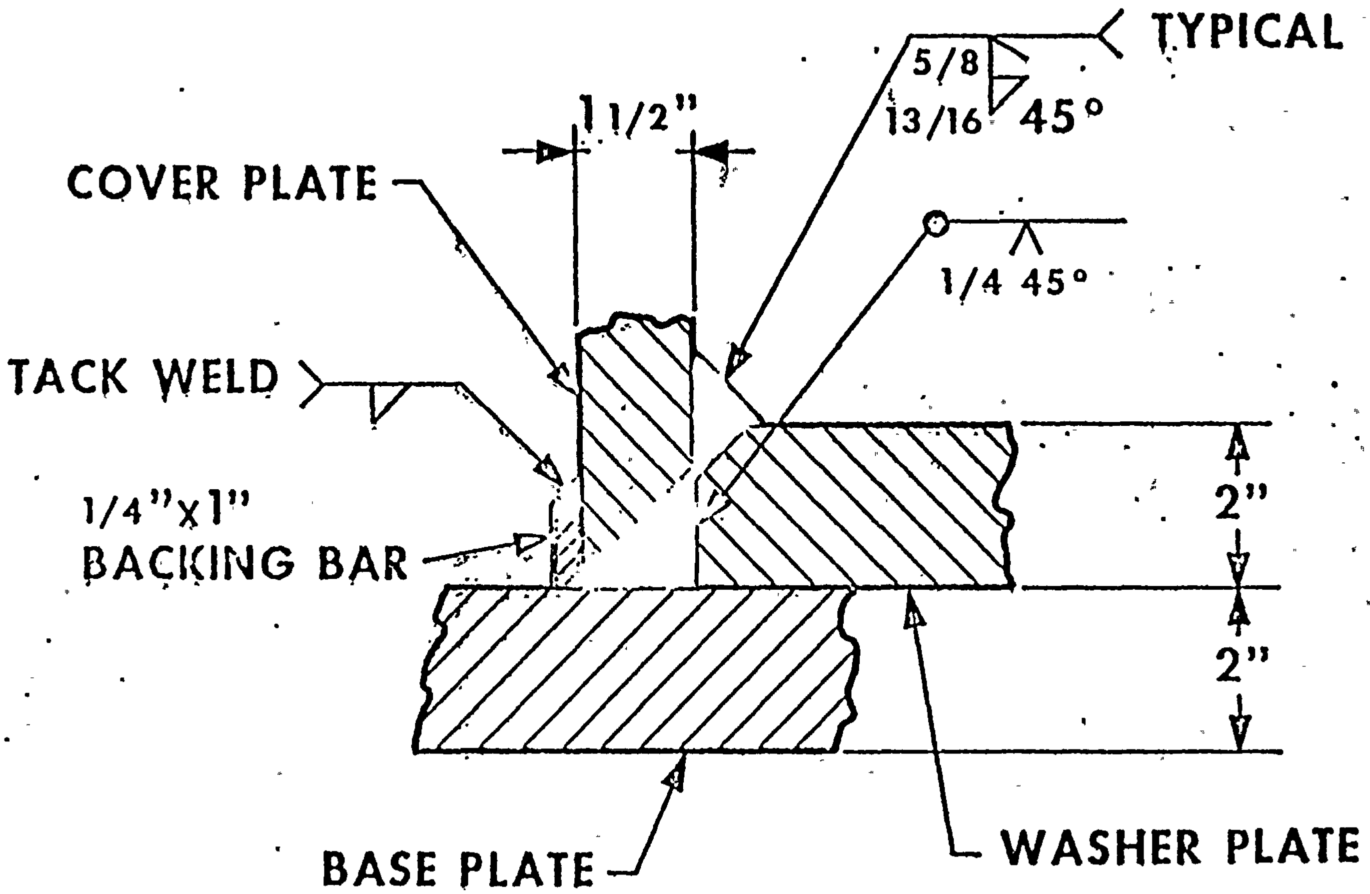

FIGURE 5

VERTICAL STIFFENER TO INSIDE AND OUTSIDE WALL PLATES

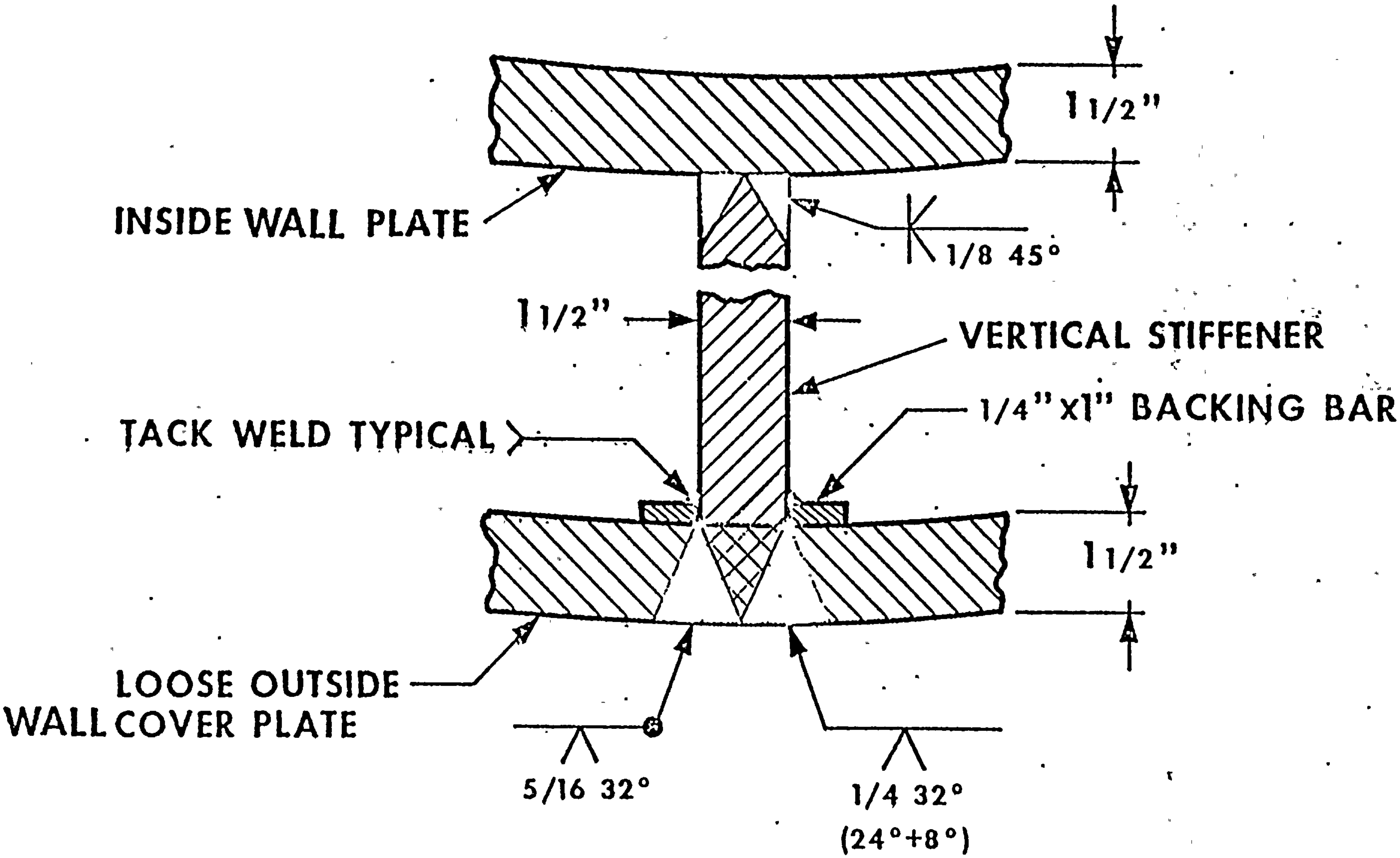

FIGURE 6

HORIZONTAL STIFFENER TO VERTICAL STIFFENER WELDS

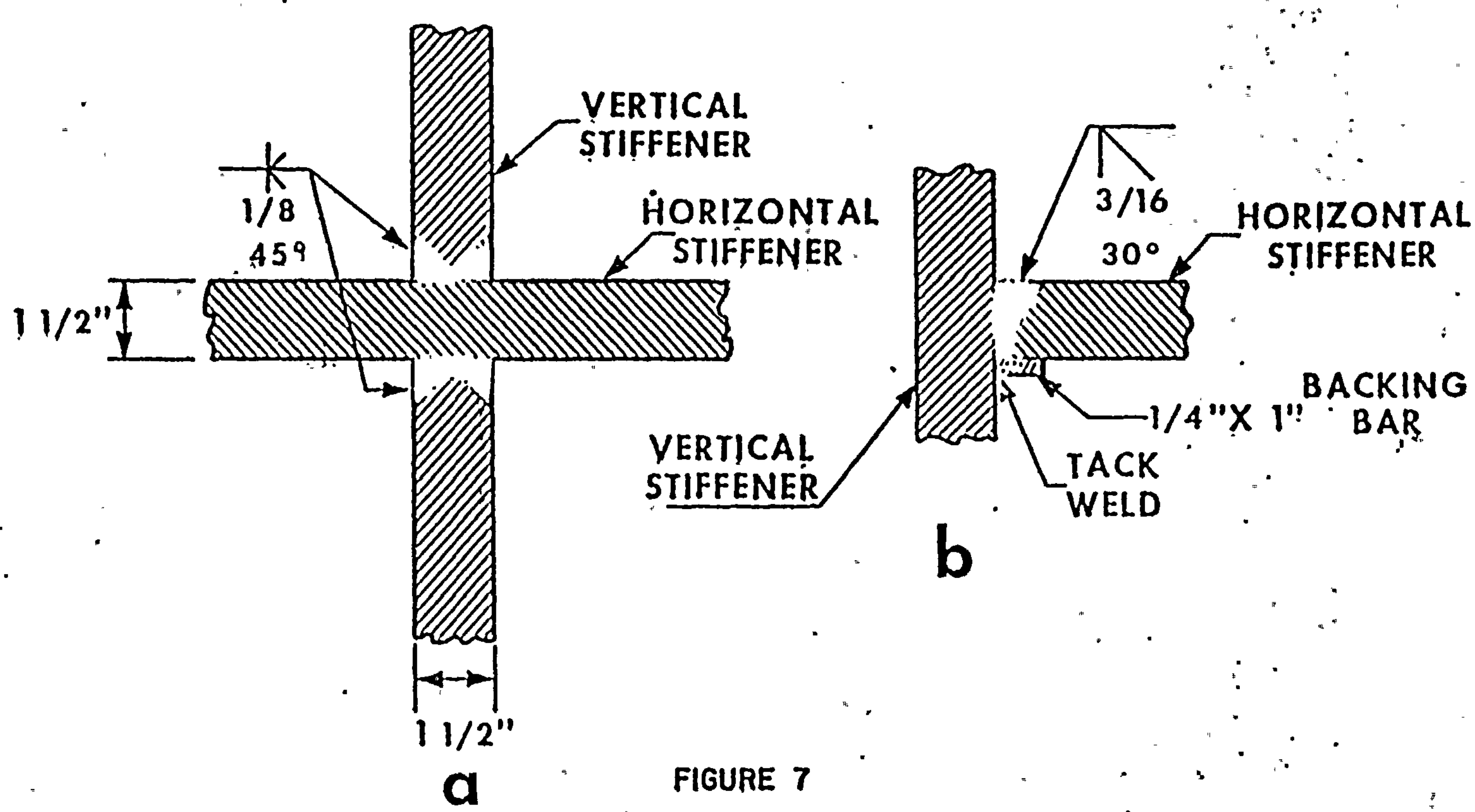

FIGURE 7

HORIZONTAL STIFFENER TO INSIDE AND OUTSIDE WALL PLATES

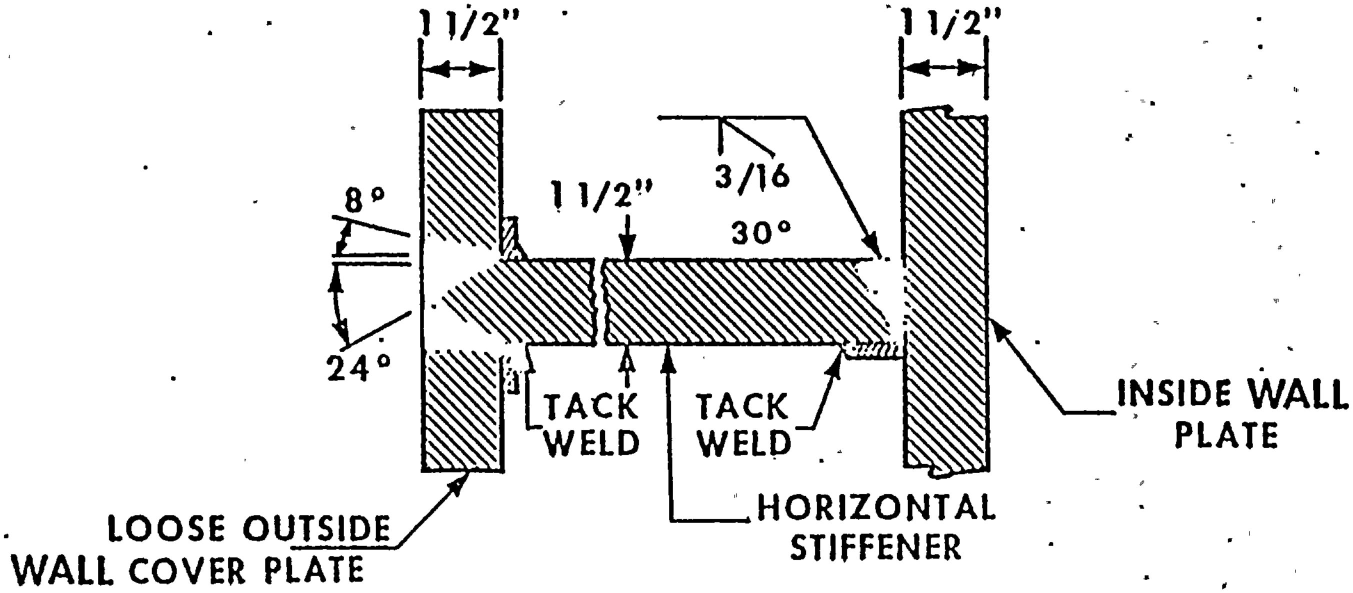

FIGURE 8

July 3. The cover plate to base plate weld joints were dispositioned to require 100 percent UT inspection and repaired as required. The UT was performed in accordance with AWS D1.1 with a 1/8 inch exclusion allowed at the root of the weld (based on engineering evaluation). This UT was completed (with the exception of two indications which are currently under engineering evaluation) in September 1979.

By evaluation of data obtained to that time, it was concluded that the horizontal stiffener to inner wall welds on the first and second rings were acceptable but the third ring horizontal stiffener to inner wall welds were rejectable and would require complete reinspection and rework, as required.

C. <u>Phase III - Sample Plan Approach</u> (August 1979 to December 1979)

Since the inital engineering investigation was primarily concerned with the root of the welds, inspections were performed using MT methods. Subsequent investigations to determine the quality of the entire volume of the welds were made using UT methods in accordance with the sample plan. The purpose of using a sample plan approach was to verify the quality of backing bar welds by using a more rigorous, systematic approach. A nationally recognized sampling approach (Appendix A) using confidence levels consistent with levels previously employed was chosen.

The sequence of events for the third phase is as follows:

August - September 1. An effort was made to establish confidence levels based on the data available from the engineering investigation. An additional 91 inches of MT inspection on the first ring horizontal stiffener to inner wall welds was performed to fulfill the root sample size requirements. Based on the MT sample plan, the horizontal stiffener to inner wall welds for the first and second rings was acceptable and for the third ring, rejectable.

September-October 2. Thirty cover plates were removed from the third ring to provide accessibility for reinspection and rework of the horizontal stiffener to inner wall welds.

October - November 3. The sample plan approach was extended to all weld configurations, including weld joints without backing bars, by the use of ultrasonic testing.

October – November (Cont'd)	3.	The weld joints were compiled into 18 weld groups (Appendix B) based on the ring (i.e., first, second, or third), the joint configuration (i.e. single bevel weld with backing bar or double bevel weld without backing bar), and the thickness of the plates being connected (i.e., 1 1/2-inch to 1 1/2-inch plates or 1 1/2-inch to 2-inch plates).
November	4.	Two specimens were removed from the third ring horizontal stiffener to inner wall welds to perform a metallurgical examination.
November–December	5.	UT inspection of the 18 weld groups was performed by a certified Level II inspector. UT data previously taken during the engineering investigation was also incorporated into a sample plan approach.

Based on the sample plan UT data of record, 11 of the 18 weld groups were rejected, 4 were accepted, and 3 were not applicable to the sample plan. (The sample plan results and dispositions are presented in Appendix C). Due to the high number of rejected weld groups, it was determined that all welds which were accessible for inspection would be inspected by UT.

IV. Closure Plan

A. Approach

The plan to resolve the biological shield wall weld problems is as follows:

1. Completely reexamine the inner wall to stiffener welds for all three rings and repair, as required, based on an engineering evaluation of the defects. The engineering evaluation will be performed using loads and allowable stresses consistent with PSAR requirements.

2. Evaluate stiffener to stiffener welds for all three rings using data from the inner wall to stiffener reexamination and repair as required.

3. Completely reexamine all cover plate to stiffener welds for all three rings and repair, as required, based on an engineering evaluation of the defects. The engineering evaluations will be performed using loads and allowable stresses consistent with PSAR requirements.

4. Reattach all third ring cover plates which were previously removed for accessibility, to the horizontal stiffener to inner wall welds.

Inner Wall to Stiffener Welds

The results of the inner wall to stiffener sample plans showed that the first and third ring horizontal stiffener to inner wall (Figure 8) and the third ring vertical stiffener to inner wall (Figure 6) weld groups were rejectable. Therefore, the inner wall to stiffener welds on all three rings are being ultrasonically inspected from the inner wall side. Special UT techniques have been developed for the inspection of these welds. These UT techniques are qualified by the use of a test block and are not standard AWS techniques. The UT defect sizes and locations larger than 1/8 inch will be mapped. The 1/8 inch criteria deviates from AWS D1.1 but has been determined to be acceptable by engineering evaluation. Dependent on the defect sizes and locations, repairs will be performed, as required, based on engineering evaluation to determine allowable defect size for given locations.

Stiffener to Stiffener Welds

A large majority of the horizontal stiffener to vertical stiffener and vertical stiffener to horizontal stiffener (Figure 7) weld joints are inaccessible. In order to determine their acceptability, the UT defect data from the horizontal stiffener to inner wall and vertical stiffener to inner wall examinations will be used in an engineering evaluation.

Cover Plate to Stiffener Welds

The results of the cover plate to stiffener sample plan shows that the first and second ring cover plate groups were rejectable. Therefore, the cover plate to stiffener welds are being ultrasonically inspected on all three rings and the defect sizes and locations larger than 1/8 inch will be mapped. Dependent on the defect sizes and locations repairs will be performed as required, based on engineering evaluation of acceptable defect size for each location. The third ring cover plates, which were removed for accessibility to the horizontal stiffener to inner wall welds, will be reattached.

B. Determination of Cause of Weld Defects

Five weld specimens (four horizontal stiffener to inner wall and one cover plate to base plate samples) have been removed from the BSW. Metallurgical evaluation of the specimens is continuing in an attempt to determine the cause of the weld defects. Additional specimens may be removed as required to aid in the evaluation.

C. Erection Strategy

Prior to setting the biological shield wall in August 1980, the three rings will be fit-up and welded together. As much of the inner wall and cover plate UT and repair as possible will be completed and the three rings will be post weld heat treated. Following setting of the biological shield wall, the remainder, if any, of the repairs and engineering evaluation will be completed. The biological shield wall will be filled with concrete, and the remaining cover plates will be attached.

V. Metallurgical Evaluation

A. Cover Plate to Base Plate

An approximately 18-inch-long section of the cover plate to base plate weld was removed for metallurgical analysis in June 1979. The analysis is complete and shows that no defects greater than 1/8 inch were present in the sample and that the small defects which were considered to be welding and fabrication related had arrested themselves in ductile areas. With the exception of the observed small defects (up to 1/8 inch), the overall metallurgical quality of the welds was considered acceptable.

B. Horizontal Stiffener to Inner Wall

The evaluation of two metallurgical samples (removed in November 1979) of the horizontal stiffener to inner wall welds, discussed in our interim report dated January 15, 1980, showed that the weld defects present in the sample were small, and that the largest detected defect arrested itself in a ductile area.

A third metallurical specimen was taken in February 1980 from the horizontal stiffener to shield wall welds and was found to contain a 3/8 inch defect. A final report on the third specimen is currently being prepared. Although the fracture surface shows that a weld repair which was done adjacent to this defect probably has not affected the defect length, a fourth specimen, free of these complications, has been removed in April 1980 for evaluation. At this time, a determination has not been developed to the precise cause of the defects.

APPENDIX A

SAMPLE PLAN

Military Standard 105D, "Sampling Procedures and Tables for Inspection by Attributes" was used as the basis for sample sizes and accept limits. The welds were broken up into a series of configurations within each ring with each configuration comprising a unique population in terms of sampling inspection. All measures of population length, length examined and length rejected were in linear inches. A confidence level of 95 percent was established which ensured that lots of 5 percent or more defective would only be acceptable 5 percent of the time. This use of the Limiting Quality or Lot Tolerance Percent Defective approach was taken due to the one time sample application.

Test data taken prior to sample size determination was integrated into the sample testing effort. A number of configurations failed to meet the acceptance limit.

Due to these failures, additional testing, including complete UT inspection of the horizontal and vertical stiffener to inner wall welds by special techniques is being undertaken.

All areas evaluated to be in excess of test acceptance criteria in AWS D1.1 or other established criteria have or will be documented and dispositioned by Engineering.

APPENDIX B

WELD GROUPS

Weld Description - Ring 1	Group	Figure
Cover Plate to Base Plate	1-1	B5
Vertical to Horizontal Stiffener Vertical Stiffener to Inner Wall	1-2	B2
Inner Wall to Base Plate Vertical Stiffener to Base Plate	1-3	B6
Horizontal Stiffener to Inner Wall Horizontal to Vertical Stiffener	1-4	B1
Cover Plate to Horizontal Stiffener Cover Plate to Horizontal Stiffener Cover Plate to Vertical Stiffener	1-5	B8 B11 B11
Ring 1 Girth	1-6	B3

Weld Description - Ring 2	Group	Figure
Vertical to Horizontal Stiffener Vertical to Inner Wall	2-2	B2
Horizontal Stiffener to Inner Wall Horizontal to Vertical Stiffener	2-4	B1
Cover Plate to Horizontal Stiffener Cover Plate to Horizontal Stiffener Cover Plate to Vertical Stiffener	2-5	B8 B11 B11
Ring 2 Girth Horizontal Stiffener Butt	2-6	B3

Weld Description - Ring 3	Group	Figure
Vertical to Horizontal Stiffener Vertical to Inner Wall	3-2	B2
Horizontal Stiffener to Inner Wall Horizontal to Vertical Stiffener	3-4	B1

Weld Description - Ring 3	Group	Figure
Cover Plate to Horizontal Stiffener		B8
Cover Plate to Horizontal Stiffener		B11
Cover Plate to Vertical Stiffener	3-5	B11
Ring 3 Girth	3-6	B7
Horizontal Stiffener Butt		B3
2" Top Horizontal Stiffener Butt	3-7	B4
2" Top Horizontal Stiffener to Inner Wall	3-8	B10
Vertical Stiffener to 2" Top Horizontal Stiffener	3-9	B6
2" Top Horizontal Stiffener to Cover Plate	3-10	B9

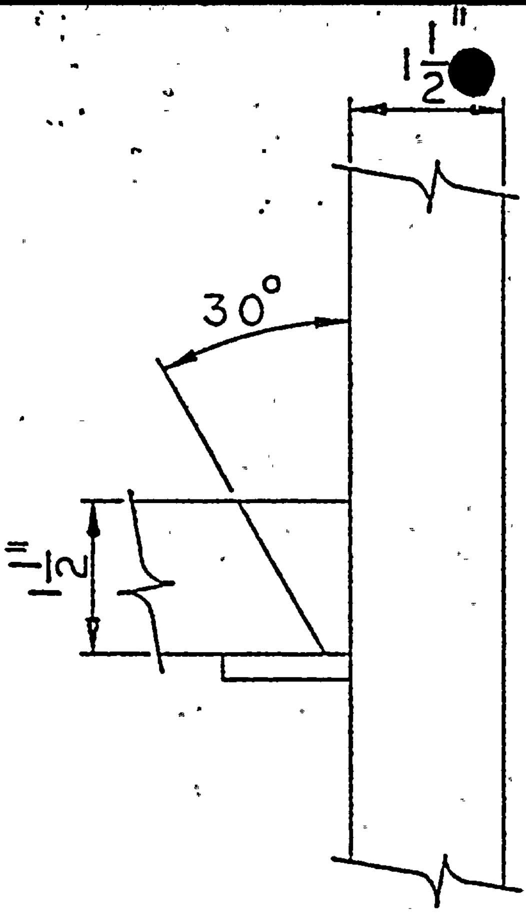

FIGURE B1
WELD GROUPS
1-4, 2-4, 3-4

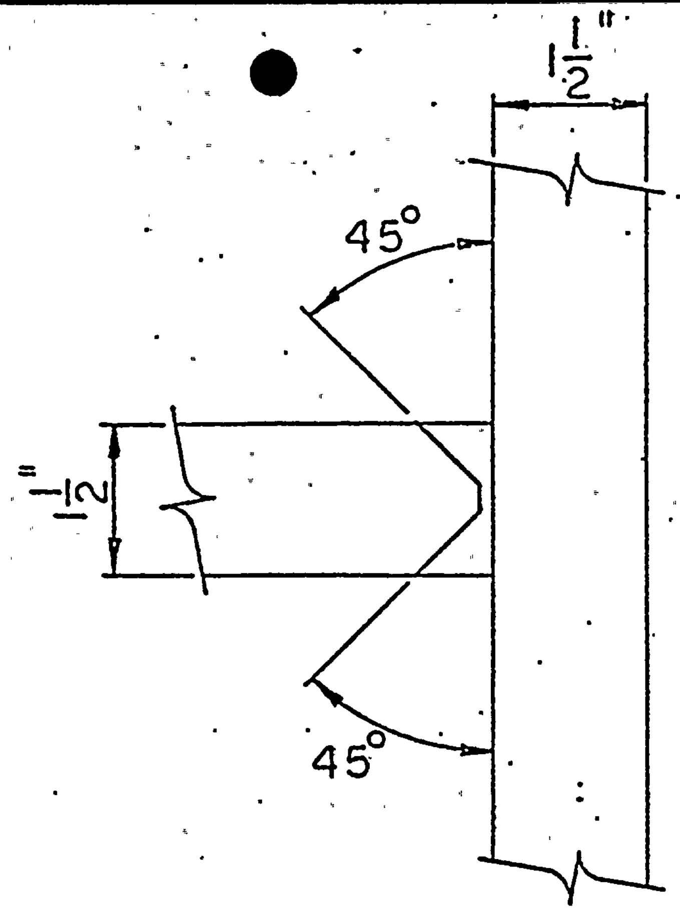

FIGURE B2
WELD GROUPS
1-2, 2-2, 3-2

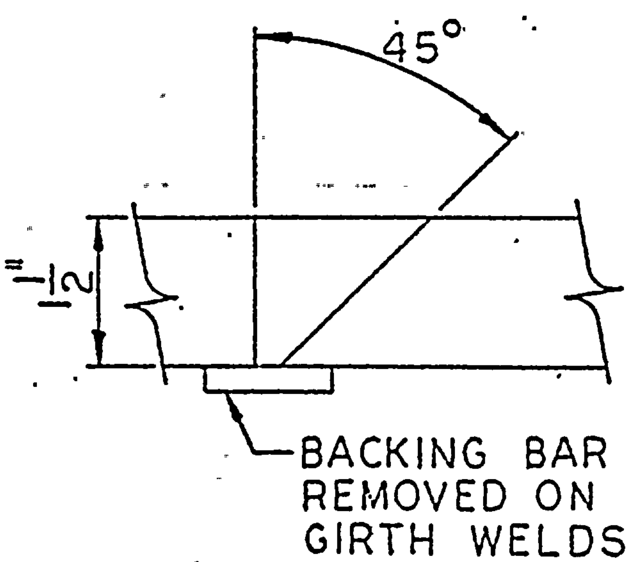

FIGURE B3
WELD GROUPS
1-6, 2-6, 3-6

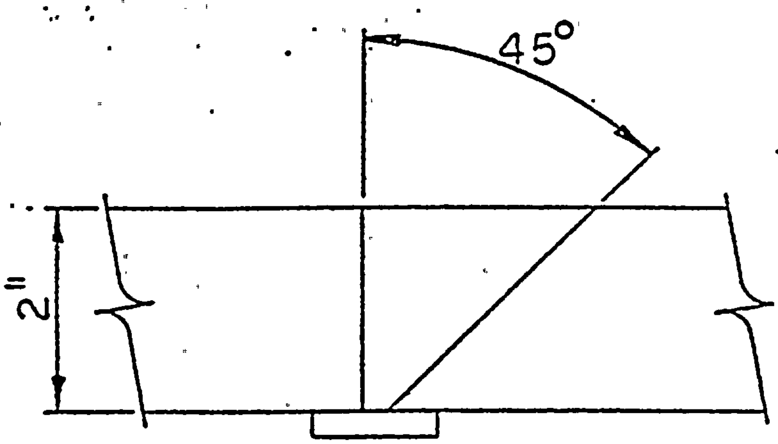

FIGURE B4
WELD GROUP
3-7

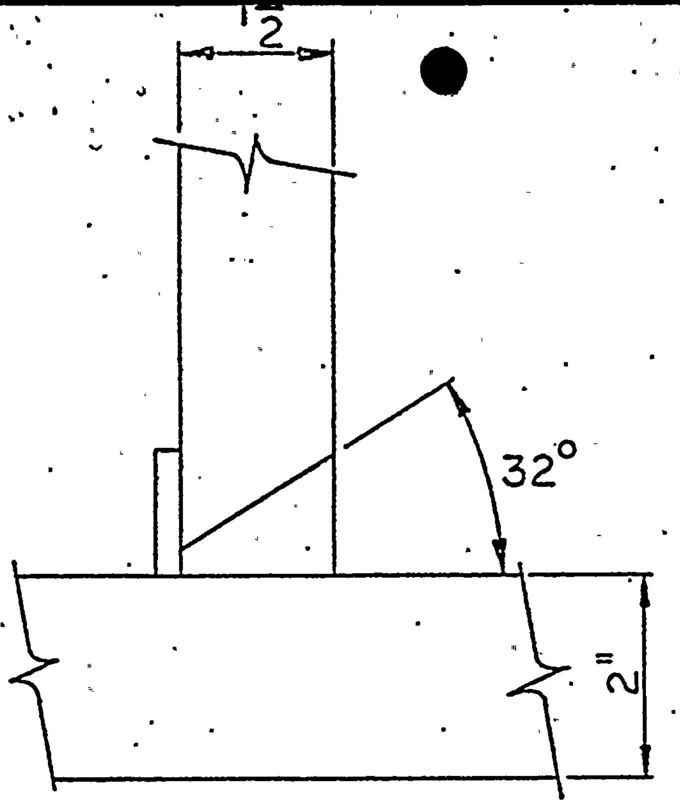

FIGURE B5
WELD GROUP
1-1

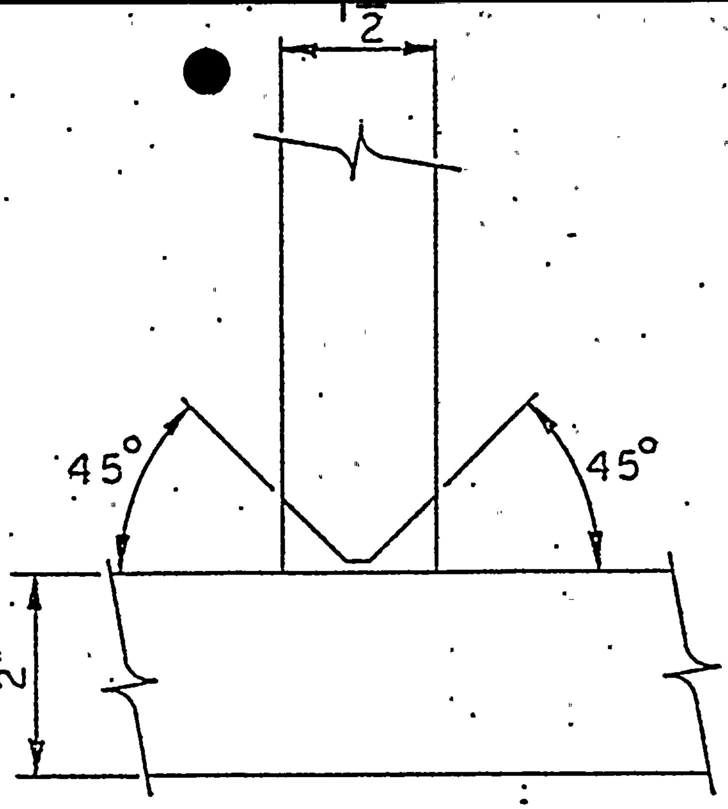

FIGURE B6
WELD GROUPS
1-3, 3-9

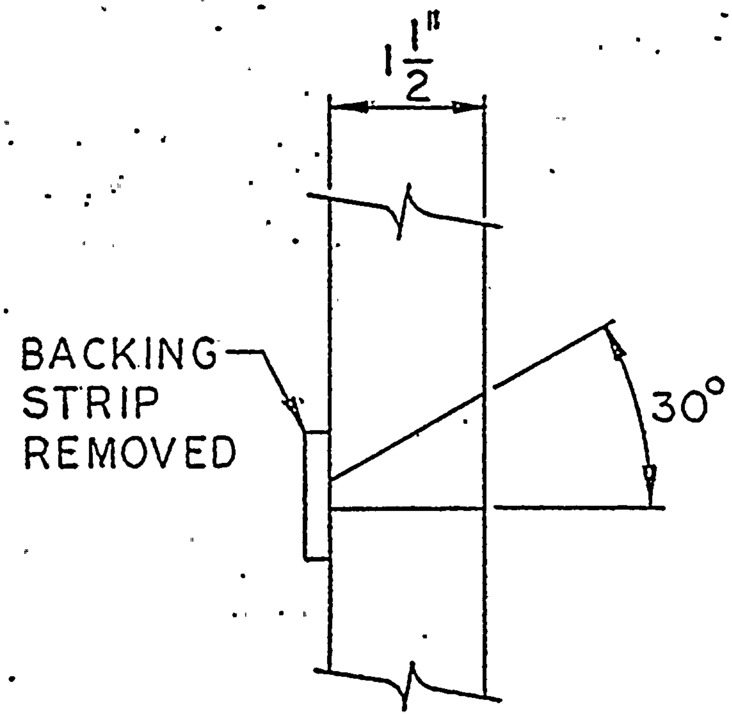

FIGURE B7
WELD GROUP
3-6

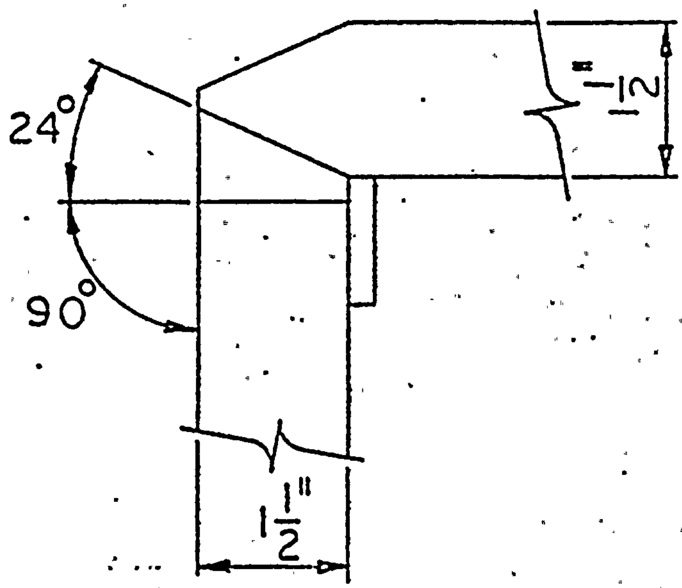

FIGURE B8
WELD GROUPS
1–5, 2–5, 3–5

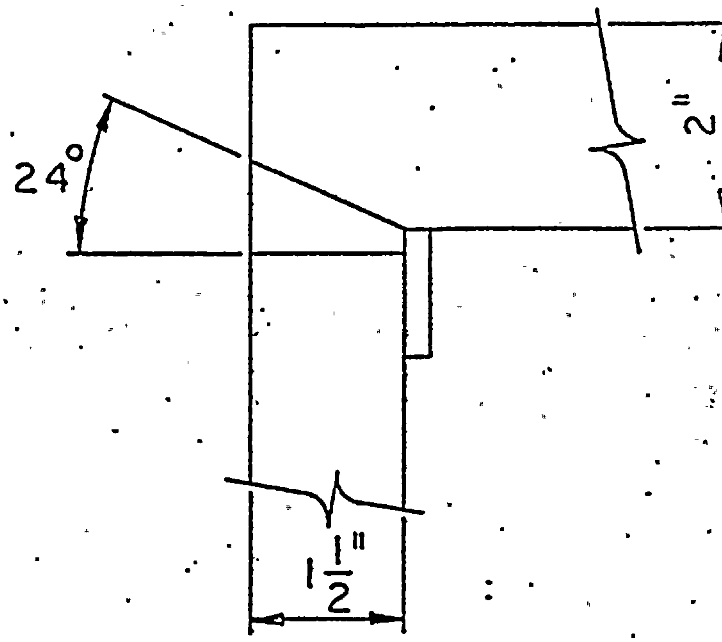

FIGURE B9
WELD GROUP
3–10

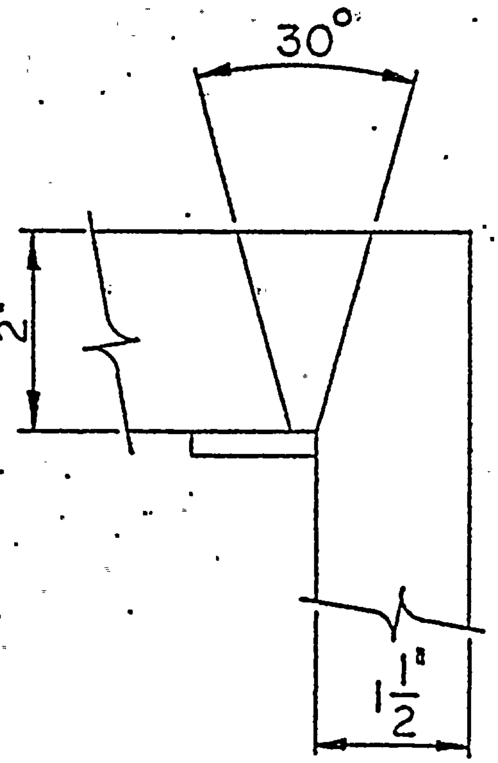

FIGURE B10
WELD GROUP
3–8

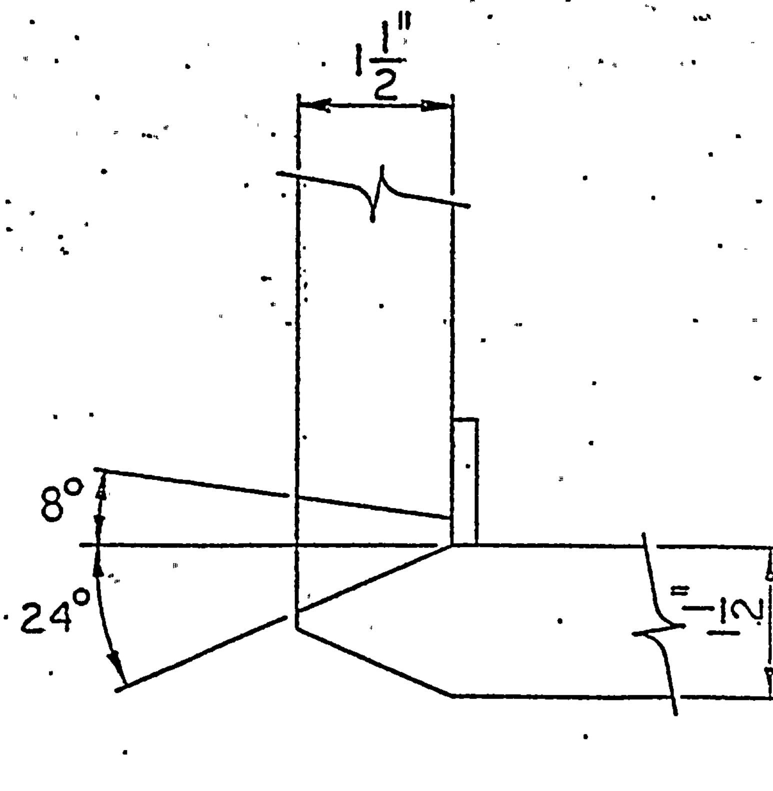

FIGURE B11
WELD GROUPS
1–5, 2–5, 3–5

APPENDIX C

SUMMARY OF SAMPLING DISPOSITIONS - 18 WELD GROUPS

o.	Group No.	Designation	Single/ Double	Overall Length (Inches)	Sample Size/ Rej Limit (Inches)	Length Ex'd/ Length Rej (Inches)	A/R Per Sampling Plan	Disposition	Basis
1	1-1	CPBP	S	1,086	80/2	980/NA	N/A	Complete UT & Rework, 90% Complete	Spec. Requirements
2	1-2	VSHS VSIW	D	9,233	200/6	200/2 1/8	A	Accept as-is Complete UT/Limited Repair	Sampling Plan Stress Analysis
3	1-3	IWBP VSBP	D	1,570	125/3	981/21 5/6	R	IWPB Complete UT & Rework, VSBP & 6% IWBP Accept as-is	Sampling Plan Stress Calc.
4	1-4	HSIW HSVS	S	6,588	200/6	200/9	R	Complete UT/Limited Repair	Sampling Plan Stress Analysis
5	1-5	CPHS CPWS	S	19,577	315/8	936/104	R	Complete UT/Limited Repair	Sampling Plan Stress Analysis
6	1-6	Girth	S	1,060	80/2	80/1 1/8	A	Accept as is, Complete UT/Limited Repair	Sampling Plan Spec. Requirements
7	2-2	VSHS VSIW	D	9,008	200/6	200/2 1/16	A	Accept as is, Complete UT/Limited Repair	Sampling Plan Stress Analysis
8	2-4	HSIW HSVS	S	5,841	200/6	200/1 1/2	A	Complete UT/Limited Repair, Accept as is	Sampling Plan Stress Analysis
9	2-5	CPHS CPVS	S	17,344	315/8	516/33	R	Complete UT/Limited Repair	Sampling Plan Stress Analysis
0	2-6	Girth HS Butt	S	1,288	125/3	125/4 5/8	R	Complete UT/Limited Repair of Girth, HS Butt Accept as-is	Sampling Plan Stress Analysis
1	3-2	VSHS VSIW	D	10,199	315/8	315/8	R	Complete UT/Limited Repair Accept as-is	Sampling Plan Stress Analysis

APPENDIX C

SUMMARY OF SAMPLING DISPOSITIONS - 18 WELD GROUPS (Continued)

o.	Group No.	Designation	Single/ Double	Overall Length (Inches)	Sample Size/ Rej Limit (Inches)	Length Ex'd/ Length Rej (Inches)	A/R Per Sampling Plan	Disposition	Basis
2	3-4	HSIW HSVS	S	6,600	200/6	748/36 3/8	R	Complete UT/Limited Repair; Accept As-is	Sampling Plan Stress Analysis
3	3-5	CPHS CPVS	S	20,914	315/8	676/0	N/A	33% of Cover Plates Removed to gain accessibility; complete UT/ Limited Repair	Spec. Requirements Stress Analysis
4	3-6	Girth HS Butt	S	1,288	125/3	125/1 3/8	A	Complete UT/Limited Repair	Sampling Plan Stress Analysis
5	3-7	2" HS Butt	S	57	N/A	57/2 5/8	N/A	Complete UT & Rework Required	Sampling Plan
6	3-8	2" HSIW	S	1,060	80/2	80/2 3/4	R	Complete UT/Limited Repair	Sampling Plan Stress Analysis
7	3-9	VS 2" HS	D	473	80/2	80/8	R	Accept as-is	Stress Analysis
8	3-10	CP 2" HS	S	1,189	80/2	80/10	R	Complete/Limited Repair	Sampling Plan Stress Analysis

APPENDIX D

BSW HSIW WELD JOINT MT DATA(4)

Ring	1/8-1/4(1)	1/4-3/8	3/8-1/2	1/2-3/4	3/4-1-	Total Defect Length	Total Length Examined
1	5	0	0	0	0	5	204
2	2	0	0	0	0	2	283
3(2)	273.1	60	28	104	10	475.1	2172
3(3)	391.6	31.5	35.3	2	0	460.4	950.3

1. 1/8 - 1/4 is read "1/8 inch < defect ≤ 1/4 inch"
2. This data does not include the data shown on the next line.
3. MT data in the 30 compartments made accessible by cover plate removal.
4. All units are in inches.